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3rd Australasian Engineering Heritage Conference, Dunedin

This special issue of the EHA Newsletter concentrates on the outcomes of the Dunedin conference and its associated tours and activities. Articles include summaries of some of the papers presented including Australian, New Zealand and international subject matter.

It has been customary for Engineering Heritage Australia and the Engineering Heritage Board of IPENZ to collaborate on conferences. Engineering Heritage conferences had previously been held in New Zealand in 1994 (Christchurch) and 2000 (Auckland) making the 2009 Dunedin conference the third to be held in New Zealand.

Dunedin is an ideal place to hold such a conference with the facilities of the Salmond College of the University of Otago being used both for the conference venue and for accommodation. A small committee from the Otago/Southland Chapter of the IPENZ Engineering Heritage Board organised the conference. Particular thanks go to John Henderson who was Conference Convenor and to Lloyd Smith, Darrel Robinson, Craig Bush and Fay Duncan who made up the Organising Committee.

The format of this conference consisted of two days of paper presentations broken into two streams with a total of 35 papers being delivered of which seven were by Keynote Presenters. The two-stream format is advantageous as it enables more papers to be delivered without extending the length of the conference. The organisers made excellent choices in the way they split the papers so that most conference participants got to hear the papers they were most interested in.

There was a four day pre-conference tour and several short tours on the day after the conference proper ended. The pre-conference tour made good advantage of the extensive engineering heritage sites in the Otago Region and was packed with interesting sites, whilst the shorter tours concentrated on sites within the Dunedin area.

There was the traditional conference dinner at the end of the conference on the Tuesday evening which included presentation of awards as well as a good social get-together after two very full days of paper presentation. EHA was able to make the 2009 Colin Crisp Award presentations at the dinner, for which we thank the organisers of the conference.

Owen Peake

A Historic ACT Bridge and Three Determined Professional Engineers

Tharwa is a small village located to the south of Canberra which, despite the controlled spread of suburbia, still remains largely as serene as it was when first settled in the early 19th century. Located on a bank of the Murrumbidgee River and nestled between dominant mountain ranges, the village has an idyllic charm. It was in this location, at the site of a low level ford, that the NSW government decided to bridge the river to satisfy public demands to open up agricultural lands. This occurred in the mid 1890s, nearly two decades before Canberra was chosen as the Australian capital.

The bridge, to the design of Percy Allan of the New South Wales Public Works Department, contains four timber truss spans and over time it and the adjacent village have become as one – a marriage which occurred 115 years ago. Allan designed 105 timber truss bridges, the construction of which provided flood-free crossings of the State's waterways for road traffic. Allan's design used timber as the main construction material and the design was unique because each truss member comprised two elements which allowed members to be replaced without the need to close the bridge to traffic. This worked well for the design load, namely a

Tharwa Bridge before closure and start of conservation

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steam traction engine of 16 tons, but the density and loading of modern traffic has meant that closure for repairs is now preferred for safety reasons.

Hardwood timber sourced from the northern NSW coast was a design strength, as it reduced the need to import heavy wrought iron components, but it eventually became a limiting factor because of timber degradation. Over the last four decades of the 20th century the bridge faced a very uncertain future as replacement by either reinforced or prestressed concrete structures was deemed financially viable. Essentially, successive governments did not maintain the old structure, compounded by out-sourcing and a continuing loss of skills in timber bridge engineering.

Somehow the bridge managed to survive, but in 2005 it was closed because of partial failure of a truss. Despite strong public opinion for retention of the bridge, the ACT government accepted a design for a prestressed concrete replacement and construction tenders were called in 2007. The intention was to demolish the old bridge and digital records were taken of what remained – a bridge in very poor condition only standing because of support from hired steel bridge panels.

But this did not eventuate, which may have something to do with the determination of three engineers who steadfastly worked behind the scene from 2005 onwards, arguing for retention of the existing structure as the only in-service bridge at Tharwa. This was going on at a time when many, including members of Engineers Australia, accepted that the case was lost and a digital record was an acceptable option. Three professional engineers saw it differently.

Brian Pearson and Ray Wedgwood are retired NSW Chief Bridge Engineers. Brian was the last Chief in the Department of Main Roads and handed over to Ray on the eve of the formation of the Roads and Traffic Authority, which replaced the DMR. Brian and Ray, via letters, lobbied the then Prime Minister, John Howard, and ACT Government Chief Minister, Jon Stanhope, arguing for funding to allow the structure to be restored and remain as the only crossing point of the Murrumbidgee River at Tharwa. The two Chief Bridge Engineers regarded the structure as a National treasure that should be preserved.

Concurrently Gary Barker, a UNSW academic based in the ACT, had been working independently of Brian and Ray, also arguing for the same outcome through contact with the press and local community. He is a former chair of the ACT Engineering Heritage Panel and the engineering member of the ACT Heritage Council. He eventually resigned from Engineers Australia and Council strongly believing that the only way he could save the bridge was to act independently.

It was not until 2007 that the trio met and this followed from a one day workshop set up by the ACT Chief Minister to analyse the case for retention of the bridge. The recommendation of the workshop was to retain the bridge, which was eventually accepted by the Chief Minister. The tender that had just been called to construct the replacement bridge was cancelled.

The three engineers were elated with this news and thought that their job was done. However, they were soon contacted by the ACT government and invited to be the Peer Review Group which was to be set up as part of the project management team responsible for design and reconstruction. Brian and Ray were nominated by the ACT Heritage Council, and Gary was nominated by Mr Tony Gill, the Director of ACT Roads, Department of Territories and Municipal Services.

The three engineers still remain on the project which has now moved from the design to construction phase with the bridge due for completion in 2011. None of the members of the Peer Review Group will ever claim that the retention of the structure was solely due to their efforts, as many people and organisations, including the National Trust, were involved. However, through all of this work one of their opinions has never faltered - the best way to preserve a historic engineering structure is to keep it in service and provide funds for regular maintenance. The final project of the Peer Review Group is to prepare a Maintenance Manual to enable the bridge to remain in service for an indefinite period.

Brian Pearson, Ray Wedgwood and Gary Barker

The Otago Central Rail Trail: 'From Steam Trains to Pedal Power'

Preservation of Heritage through Development for Visitor Use

In 1990 the railway line to Central Otago was closed as the Clyde Dam hydroelectricity project was completed. At the same time the need to retain part of the former Otago Central Railway line between Middlemarch and Clyde was being discussed with recreationists and others promoting an overseas concept known as 'Rail Trails'. Between 1994 and February 2000 when the Otago Central Rail Trail was officially opened along its full 152km length, the Department of Conservation (DOC), with support from the Otago Central Rail Trail Trust, redeveloped the former railway corridor for use by walkers and mountain bikers.

The impressive Poolburn Viaduct showing the detailed stone work and major engineering involved

Originally the Otago Central Railway was constructed to transport gold from the booming Central Otago goldfields of the late 1800s into the bustling Dunedin City. Otago was once the hub of New Zealand's economy. The discovery of payable gold in 1861 brought a rapid influx of miners and entrepreneurs, farmers and families. Towns were built along with roads, and finally a railway. In the days before the railway it could take two days by coach from Dunedin to reach the Central Otago towns of Alexandra and Clyde.

Construction of the Otago Central Railway began on 7 June 1879 near Dunedin. Progress was slow due to the rugged terrain and it wasn't until January 1891 that the line reached Middlemarch (today an hour's drive from Dunedin). The remaining 152 km of line was pushed through to Alexandra and on to Clyde by April 1907.

Where once the railway was created in a clamour of picks, shovels, hammers, horse and wagon teams, dynamite explosions and the shouts of working men, today all you hear is the crush of gravel from the walkers and cyclists passing through the striking Central Otago landscapes, away from roads and traffic. Managed by DOC as a public recreation reserve, there is nothing quite like it in New Zealand. It is not only an important heritage site preserving, as it does, the route and the engineering achievements of those early pioneers, but also a major regional and national tourism attraction in its own right. Notably, the Rail Trail project has also encouraged an appreciation of the heritage past in communities along the route. In the 68 bridges retained and adapted for their new use, many types and styles of engineering can be seen, reflecting the changes in terrain, materials and technology over the 16 years of construction. Outstanding bridge examples include:

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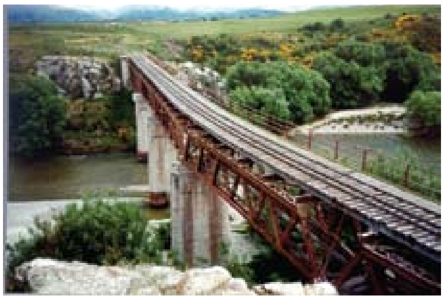
Poolburn Viaduct

The highest bridge on the line was completed in 1901 and is also the one with the longest span (47.5 m for one of the centre spans). It is the second longest bridge on the Rail Trail (108 m) and represents the last of the big masonry pier bridges (with steel trusses) built on the line. Even in 1901 it was something of an anomaly. The abutments, 36.8 m high, are made of beautifully trimmed and bolstered stone, all brought perfectly to course. During construction large gantry hoists were used to lift and position the stone slabs. Holes on the stone piers show where these hoists were fitted during construction. All the stone was locally quarried from outcrops close by.



Manuherikia No. 1

Manuherikia No.1 Bridge

Completed in 1903, this is the longest bridge on the Rail Trail at 110.6 m and is the first example on the railway line of true concrete pier bridges. The foundations here were built by sinking caissons into the river bed. These were filled with compressed air for the men to work in. When the caissons were sunk far enough, the men were taken out and the concrete fill poured in. The piers were built with a taper. The bridge is one of only two curved bridges on the whole 152 km Rail Trail.

Today, all who ride or walk the Otago Central Rail Trail take away something different to treasure in their memories, be it discovering the tough and adventurous Otago history, marveling at the engineering feats of those early pioneers or the wild, natural surroundings or a chat with a local at the pub.

Owen J. Graham

(Owen Graham worked for DOC and was involved in the earliest investigations into the conversion of the railway line into a walking and cycling trail. He worked on the Otago Central Rail Trail project from 1993 through to 2006 as both Project Manager and Executive Officer to the Otago Central Rail Trail Trust. He is now the Otago/ Southland Area Manager for the New Zealand Historic Places Trust. For more information visit: www.otagocentralrailtrail.co.nz)

Recognised Engineering Heritage Works

Since our last edition went to press, the following works have been recognised under the Heritage Recognition Program. The transition phase has now ended and two levels of award are being given: the Engineering Heritage National Landmark (EHNL) and the Engineering Heritage Marker (EHM).

Somerset Dam near - Brisbane (EHNL)	June 2010
Umberumberka Waterworks – Broken Hill (EHM)	June 2010
Humphrey Pumps – Cobdolgla (EHNL)	June 2010

Colin Crisp – The Man Behind The Award

The 3rd Australasian Engineering Heritage Conference held in Dunedin, NZ in November 2009 saw the award of three *Colin Crisp Awards* for outstanding engineering heritage conservation projects. Given the presentation of these awards, it's perhaps timely to tell the story of Colin Crisp, and why EHA has chosen to name its prestigious conservation award after him.

Born and educated in Adelaide, Colin Crisp graduated from the University of Adelaide in 1953 and the South Australian School of Mines in 1954. Soon after graduating, he moved to Sydney where he worked initially as a structural engineer with the Cement and Concrete Association before joining the firm of Kevin J Curtin & Partners. By 1959 he had started his own consulting practice, which he managed until 1978, at which time he joined with Dale McBean to form the firm of McBean and Crisp.

Colin's interest in and, ultimately, love of the conservation of heritage structures, emerged early. By 1964 he had become Honorary Consulting Engineer for the National Trust in NSW, providing advice on the condition and restoration of the Trust's buildings. Beyond that, the Trust began to use Colin's skill to determine the structural condition of other buildings whose existence was threatened. Colin could see the beauty and significance in buildings, to the extent that he would do all he could to preserve and conserve as many of them as possible.

An example of the innovation Colin brought to his conservation work was his groundbreaking use of reinforced epoxy resin in timber beams damaged by termites. The technique was first used in Australia at Hyde Park Barracks and later on Throsby Park, the Oakey Park Colliery head frame and the Corrimal Colliery head frame. Another project of significance that he directed was the restoration of Tathra Wharf, recently recognised by EHA through the award of a National Engineering Landmark.

Another outstanding example of his innovative and world-class work was the design and supervision of the installation of post tensioning within the Sydney GPO Clock Tower for earthquake resistance. Other major heritage structures on which Colin carried out significant conservation work include the road & rail bridge at Echuca and Vaucluse House in Sydney.

Colin's abilities went beyond that of just an engineer; his willingness to pass on his knowledge made him a great teacher and he was also recognised as a great communicator, being able to explain the most complex phenomenon in the simplest terms, influencing conservation practice throughout Australia for over two decades. People who knew him talk about his wonderful personal qualities, his understanding ear, and his abilities to mentor and listen.

Colin was a member of the Engineering Heritage Committee of Sydney Division from its inception in 1978 until 1991. His long association with the National Trust (NSW) was recognised when they awarded him their Silver Medallion in 1986 in recognition of his services to the Trust. Colin Crisp died in May 1991. The Colin Crisp Award for Engineering Heritage was instituted by Sydney Division, which generously ceded it to EHA in 2004 as a national award. It is awarded for demonstrated excellence through the conservation of an engineering work, structure or building of historical or heritage significance; or the recording, research, or documentation of an engineering history or heritage subject.

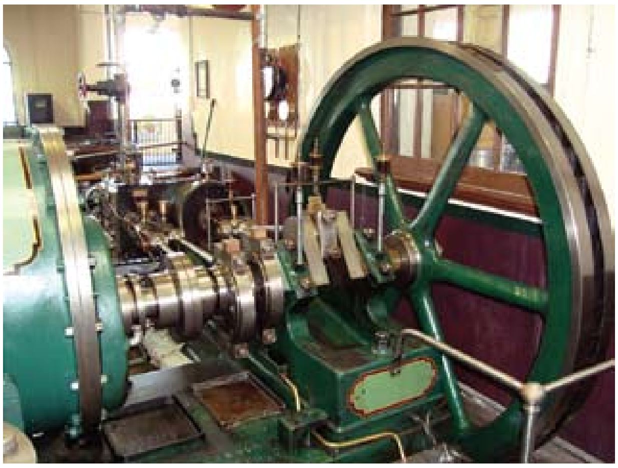
This article is based with thanks on previous work by Don Godden, Ian Bowie and EHA records.

Lyndon Tilbrook

Dunedin Gasworks Museum

As a part of an optional half-day local area tour immediately following the Engineering Heritage conference, participants visited the Dunedin Gasworks Museum.

The Dunedin Gas Light & Coke Company was established in 1862 with its progenitor and first engineer, Stephen Hutchinson, having previously been involved with gasworks in Melbourne and London. A coal carbonisation gasworks was constructed in South Dunedin, with the first gas produced early in the following year, and the plant was supplying gas street lighting later in 1863. The Hutchinson gasworks was taken over by the Dunedin City Council in 1876 and the plant expanded. Further major expansions and updating took place in 1906 and 1927. In 1962 the old horizontal retorts were replaced by more efficient vertical retorts. The gasworks finally closed in 1987 when reformed LPG replaced the old coal carbonisation technology. Dunedin was both the first city in New Zealand to have a coal carbonisation gas supply service and the last to close it down.



Part of one of the c.1926 Waller steam driven gas exhausters at the Dunedin Gasworks

Soon after the South Dunedin gasworks closed down, the retort house and other plant and related buildings where demolished, however, the boiler house, its chimney, and the adjoining engine house survived. This has become the nucleus of the Gasworks Museum run by the Dunedin Gasworks Museum Trust. Volunteers have restored the fine selection of steam driven exhausters and booster pumps in the old engine house and operate them with live steam on regular public open days.

Two c.1926 Waller & Sons vane type exhausters, driven by single-cylinder steam engines, originally drew the raw gas from the retorts where coal was heated in the absence of air, and pushed it through the subsequent gas cleaning and 'purification' processes and thence to the gas holders. The speed of the engines was regulated by bell type governors which still stand adjacent to each engine and served to maintain a pre-set negative pressure in the foul main and thus the connected retort vessels. A smaller Waller steam engine driven exhauster dates from 1909 and was later used instead of one of the larger exhausters for light demand periods. A fourth exhauster set with a totally enclosed vertical steam engine, originally built by Reader & Sons, was purchased secondhand in 1965 from the West Midlands Gas Board (UK) to increase the exhauster capacity in line with the expansion of gas manufacturing capacity.

At times of high gas demand, booster pumps were utilised to ensure a sufficient supply of gas to the outer regions. The engine house has an excellently preserved horizontal twin-cylinder steam engine direct-coupled to duplex positive-displacement compressor cylinders. This unit was made by Bryan Donkin & Co., Chesterfield, UK, in 1926. A second rotary-type Bryan Donkin booster set installed at a later time is coupled to an 80 hp, 500V DC electric motor.

Another item of particular interest is a small rotative beam engine, manufactured by the Garrison Foundry in Falkirk, Scotland, and brought to Dunedin in 1868. Although no longer connected to a driven machine, it is also a working exhibit. It is believed that it was formerly used to drive an exhauster in the original gasworks.

The engine house also contains a range of related gas industry artifacts, including gas pressure regulating governors, gas metering and test equipment, etc. A single solid-fuel boiler and a supplementary Anderson boiler housed in the old boiler house provide the steam for running of the various steam driven plant items mentioned above.

The Gasworks Museum was a highlight of a tour that also included a visit to the c.1867 Ross Creek Reservoir, Dunedin's first water supply storage dam, and inspection of the routes of Dunedin's cable trams, the first of which commenced operation in 1881 and the last running up until 1957. The final site was the Ocean Beach Railway where participants rode in carriages hauled by a small vintage steam locomotive and then on a 'jigger' motorized track maintenance trolley to inspect the Society's rolling stock storage and workshop facilities.

(Information on the gasworks museum and the gas industry in Dunedin has been drawn from the Trust's booklet: 'A Guide to the Museum's History & Displays,' plus notes made by Owen Peake and the author's own observations during the visit.)

Miles Pierce

ADVANCE NOTICE — Hobart 2011

The next biennial Engineering Heritage Conference will be held in Hobart.

The venue is the Wrest Point Convention Centre and the dates are 13-16 November 2011. There will be a four day pre-conference tour to the north and west of the State.

In order to assist engineers in the professional formation required for NPER Registration in Heritage and Conservation Engineering, plans are being made for a short course in Hobart following the conference. The short course will be conducted in association with Engineering Education Australia.

Preservation by Operation - Sobering Thoughts

There have been some remarkable achievements in restoring stationary steam engines to working order in the past fifty years. Water pumps, in particular, have attracted groups whose objective is to restore them to an operational condition and attract enough paying visitors to fund the inevitable costs. There have been many successes, and some failures.

Kew Bridge Pumping Station, with its nest of five Cornish cycle steam pumps dating from 1820, was designated as a Museum by its then owners, the Metropolitan Water Board in June 1944. In 1974 a volunteer trust took over and, since that time, have restored all but one of these engines to a working condition.

In the UK there are about 25 sites with active stationary steam engines. In London we have the 800 tonne monster at Kempton Park which must represent the ultimate in reciprocating steam engine design. In Australasia, the engines at Goulburn and Auckland are fine examples.

The LP crank-pin bearing of the large engine at Kempton Park, built in 1929

While there is still a tantalising number of engines still available for restoration, the real problem now is to maintain, operate and preserve this steam plant safely and effectively, while relying on the enthusiastic goodwill of volunteers, working in a non-hierarchical society with very limited funds. It is this that represents both a threat and a challenge to the professional engineer willing to become involved.

In undertaking the restoration of a large stationary steam engine there are five points to consider:

Conservation: Modification and repairs will be necessary, but these will affect the integrity of the object being preserved. There is high level guidance on what should and should not be done in the Burra Charter. Even at local level, the principles will probably apply if external funds are to be sought.

Design Standards: Was it good enough in the first place? Much of the design of early 19th century machinery was done by eye and proportioning earlier successful designs. How close was the design to failure while continuing to work successfully?

Adapting the Design: It is seldom possible to use these large engines at their design output or, indeed, any output. For Cornish cycle non-rotative engines this makes them very tricky to handle with the resulting ever–present risk of hitting the stop blocks at the end of the beam. For the rotative engines, it is not unusual for the pump load not to be present. Not only does this make an over–speed easy, it can also upset the balance of forces within the engine and the way the valve events occur. The prime example of this is the engine at Kempton Park where the forces on the bearings are three to four time those when the engine was at full output.

Operation and Maintenance: This might be called the post–natal depression phase. The fun and the target have gone. Now all there is to do is to run it. It can be boring, the visitors invading the hitherto private club tedious. It takes a different mind-set to run the engine safely in a way it was never designed to do. Formal inspections, planned maintenance routines, pre-start checks and organised driver training are now essential. There is enough evidence of damaged engines, lucky escapes and near misses to justify maximum attention to these aspects, yet they are frequently ignored as support drifts away, experienced people move on and financial realities bite.

The 1820 Boulton & Watt engine at Kew Bridge Steam Museum

Risks and Responsibilities: Cynical experience from the steam movement and the wider world suggests to me that a serious accident at a volunteer run steam museum is inevitable one day. In the UK we have no prescriptive legislation controlling how the plant is run. Each museum is responsible for its own safety. If nothing goes wrong – fine. But if something does, then the whole of the operation will be subject to severe scrutiny.

These live steam museums are wonderful places. The sight, sound and smell of a large steam engine in action are uplifting. The professional engineer has much to contribute. His knowledge of thermo-dynamics, strength of materials, operating and maintenance formalities and legal regimes are vital to safe restoration and operation. And he can still put a boiler suit on and take part, enjoying the satisfaction of getting his hands dirty again.

But he should always be ready to answer the question, “Why did you, a professional engineer, allow this to happen?”

John Porter

(John Porter attended the Dunedin conference with the Newcomen Society group. We are grateful to him for supplying this article which asks some questions which may not have been fully considered by groups in Australia. – Ed.)

High Voltage Direct Current Transmission

Transmission of electricity by High Voltage Direct Current (HVDC) has provided the electric power industry with a powerful tool to move large quantities of electricity over great distances and also to expand the capacity to transmit electricity by undersea cables. HVDC is considerably more efficient than conventional alternating current (AC) transmission with losses being only about 50% of those for AC.

The first commercial HVDC scheme connected the island of Gotland to the Swedish mainland in 1954. During the subsequent 56 years great advances in HVDC technology and the economic opportunities for HVDC have been achieved.

Early HVDC schemes used Mercury Arc Valves (MAVs) to rectify the electricity from AC to DC and vice versa. This technology was complex and development took from 1927 until the first commercial scheme at Gotland and remained the preferred technology until the early 1970s when solid state Thyristor Valves came into use. The MAVs proved to be much more robust in commercial service than expected and many remained in service into the 21st century.

Because of the rapid development of HVDC technology many of the early schemes have already been upgraded, modernised or decommissioned. Very little equipment from the early schemes has survived to illustrate the engineering heritage of HVDC. Conservation of the equipment remaining from the early projects is now an urgent priority whilst the conservation of more recent projects, when they are retired, is a future challenge. The MAVs in the New Zealand link and a link in Vancouver, Canada are the last MAVs in commercial service and now have very significant engineering heritage significance.

Those who took the Dunedin Conference pre-conference tour visited the Benmore hydro electric power station in the centre of the South Island. This station is the southern terminal of a HVDC scheme, commissioned in 1965, which connects the North and South Islands via undersea cables across Cook Strait and 535 km of 350 kV DC overhead transmission line. We were able to view the latest Thyristor technology installed recently to upgrade the link whilst nearby the older systems were on standby duty prior to retirement or were in the process of decommissioning. We saw some of the original MAVs having their mercury removed following decommissioning.

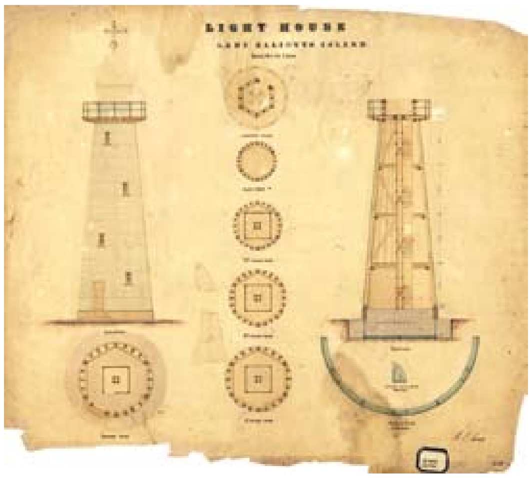
Mercury Arc HVDC Valve which we saw having mercury removed at Benmore hydro electric power station, New Zealand.

Meanwhile in China, huge HVDC schemes are being built to move vast quantities of electricity over many thousands of kilometres from hydroelectric stations on the Yangtse River to Shanghai and other major cities. These enormous and very ambitious schemes, along with a large nuclear power generation program, are amongst the largest attempts to reduce Greenhouse Gases anywhere.

Owen Peake

Queensland's Timber and Iron Lighthouses: 19th Century Colonial Innovation

I presented a paper on this subject at the Dunedin conference, prompted, in part, by a project I undertook in 2006-7 to survey the condition of 58 heritage listed lighthouses operated by the Australian Maritime Safety Authority. In the process of visiting 57 of these sites I gained a broad comparative view of Australia's historic lighthouses, and an appreciation of the regional variation among them. Each of the colonies developed its own patterns of lighthouse design, reflecting the particular circumstances there.



I think the most innovative lighthouse tower designs were created in the colony of Queensland – designs that responded to the need for navigation aids on a long and treacherous coast, with small budgets, on sites without sources of building stone or brick and with limited resources of skilled labour. Through the 1870s, '80s and '90s, 19 towers were built with timber frames and iron cladding. The towers were innovative in their use of prefabrication, in their combination of concrete, timber and iron in the one structure, and in the structural efficiency of their design.

Lady Elliot Island Interior

The first of the towers, and the prototype for the ones that followed, was erected on Lady Elliot Island in 1873. For Lady Elliot Island, the architect Robert Ferguson developed a composite form of construction, which combined the economy of timber framing with the weather-tightness and durability of iron plating. This design brought together the established materials and techniques of carpentry and boiler-making. The components of the tower were pre-fabricated on the mainland, shipped to the island, and assembled there.

The lighthouse tower was circular in plan and tapered in profile, forming a truncated cone. The battered outer walls were framed with sawn hardwood posts and rails bolted together, with joints reinforced with wrought iron straps and brackets. The walls had light timber braces which would have served to stabilise the timber structure before the iron shell was fitted. There were three intermediate floors with hardwood joists and pine floor boards. In the centre of the tower was a vertical timber weight tube, which formed a central support for a winding timber stair that climbed up the bottom three levels of the tower. On the fourth level, where the conical tower was too small to fit a stair, there was a fixed ladder up to the level of the light room and balcony.

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Report on the Preconference Tour of the 3rd Australasian Engineering Heritage Conference - Dunedin, New Zealand, November 2009

The Pre-Conference Tour of Otago for those attending the 3rd AEH Conference was held from 19th to 22nd November 2009. It was fully booked and enjoyed by 46 visitors from New Zealand, Australia and the U.K., travelling with two local engineer guides Noel Read and Rod Mcleod, with Bruce Comfort part time. The tour visited many of Otago's best engineering heritage sites of importance to NZ's rural development, power and water infrastructure, and took in significant tourism attractions on the way.

Day one took the group through North Otago; visiting Oamaru; then up the Waitaki Valley; with an overnight stay at Omarama, a world class glider centre. Clark's flour mill at Maheno displayed heritage machinery at is best. It is well preserved and has an enthusiastic volunteer team in period clothing operating the Mill. This was a delightful start. Another highlight was the outstanding stone heritage and harbour area of Oamaru, regarded as the best preserved heritage town in the country (and so being considered for world heritage status). The group gathered at the town's restored opera house to hear a speech (the first of several heard later at the Conference) from U.K. heritage expert and keynote speaker, Sir Neil Cossons. An engineering highlight was a visit to Benmore Power Station; Southern terminal for the High Voltage DC link to the North Island. The group was impressed when escorted into the valve room for this 1965 equipment, and later 'electrified' by the space-age thyristor hall buzzing with new rectifier technology. This technology transition was ably discussed later at the conference in a paper by our Chairman, Owen Peake.

IPENZ guides describe the engineering features of Oamaru Harbour. They are from left: Noel Read, Roger Blackburn in the vest and Bowler and Ken Mitchell impressively reflecting the Otago's great Scottish heritage. The "White Stone" town of Oamaru can be seen across the water.

Day 2 saw the coach travel through 'Mackenzie Country' (along pioneering sheep trails) and over the alpine backbone through the Lindis Pass. The ever-greener alpine descent to the West Coast took in Wanaka and its airfield, famous for the "Warbirds" air show every Easter. A remarkable aviation museum associated with the show was visited by the group. The tour then drove over the Crown Range to the historic gold mining area of Arrowtown, taking in the old (1915) Lower Shotover Bridge; these days finding adaptive reuse for tourism as a footbridge. Beautiful Queenstown was the overnight stop; with a Lake Wakatipu trip on the historic Steam Ship Earnslaw and an NZ BBQ at Walther Peak enjoyed by many.

Day 3 offered two tour choices for the participants: Dedicated engineering heritage fans went on a more extensive tour of Lake Wanaka onboard SS Earnslaw, and then took in dam, power station, and bridge sights along the Kawerau gorge, before stopping at Cromwell. Tourists (such as me) took the Milford Sound trip option. Seeing the Sound in a drenching rainfall was a defining "NZ" experience. Surprisingly, bottle-nosed dolphin and rare penguin sightings were facilitated by the wet conditions.

On the last day, the wonders of NZ water management were paraded in front of the jealous Australians, as the tour took in NZ's 'Think Big' water projects of the 1970/80s. Our engineering guides capably outlined the story of the enormous Clyde Dam, which showed NZ engineering capability at its best. At the dam site, earthquake fractures found in the somewhat mobile geological environment of NZ during construction required stabilisation improvements. NZ engineers dug 18 km of tunnels to drain the hillsides and slurry cement was pumped into the rock fractures to stop water leakage.

At Alexandra, the group visited a museum describing and displaying the amazing story of the gold dredges used in gold rush times. An icon of NZ agricultural industry was the Hayes Engineering Works visited near Alexandra. Well preserved, owned and managed as a tourist attraction by the NZ Historic Places Trust, this engineering works produced farm equipment for early NZ settlers. It fascinated the tour group with working displays of machinery that manufactured fencing and hardware products and provided a 'one-stop' repair shop for an isolated community.

NZ railway heritage was celebrated by a ceremony and unveiling of an IPENZ plaque for the Otago Central Railway at Middlemarch Railway Station. And, most appropriately, the tour was topped-off by a picturesque "Taieri Gorge Railway" journey down the historic gorge, directly to Dunedin. A gracious return to this city was ensured when the group alighted at the stunning Dunedin Railway Station.

Many thanks to the IPENZ organisers and the assistance of guides for this delightful heritage trip, a fitting entree to a wonderful conference.

Rod Caldwell

Continued from page 6 - Queensland's timber and iron lighthouses: 19th century colonial innovation

The frame was supported at the bottom by a segmented cast iron ring that formed a base, bolted down to a massive concrete footing and floor cast within a low stone wall. The timber posts were bolted to lugs made as part of the iron ring.

The tower was clad with a covering of galvanised wrought iron plates, about 2.5 mm thick, which were rolled to the conical shape. Joints between the plates were lapped and riveted, and the plating was screwed to the timber framework and to the iron ring at the base.

The Lady Elliot Island lighthouse tower proved very economical to build – far less costly than earlier cast iron towers imported from Britain – and is still standing, though no longer in service. 18 other towers were built to generally similar designs, ranging in height from 5 m to 24 m, of which all but two are still standing.

After Federation in 1901, and the establishment of the Commonwealth Lighthouse Service in 1912, new major Australian lighthouses lost their regional identity. The CLS engineers based in Melbourne standardised the design of towers around the country. No more of the distinctive Queensland timber and iron towers were built by the Commonwealth. A string of new offshore lights was constructed on the northern parts of the Barrier Reef during the First World War: they were built with steel lattice frames on concrete bases.

Peter Marquis-Kyle, conservation architect, Brisbane

American Bridges in New South Wales 1870-1932

Introduction

Prior to 1894 the British iron lattice girder/truss was the choice for spans exceeding 33 m in NSW, twelve were for the railways and 27 for road bridges. They were heavy and expensive but were sturdy, effective for crossing major rivers and have been long-serving: 28 survive. Despite this preference, the first American iron truss was built in 1870 over the Macquarie River at Bathurst and continues to serve as a footbridge.

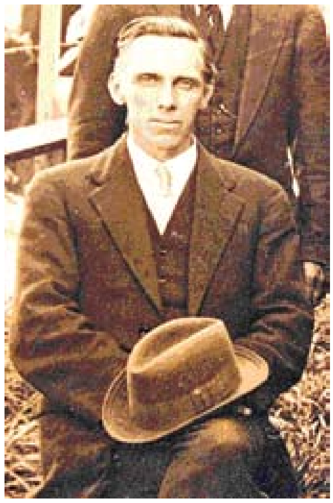
Change began in 1883 with the dissemination of American bridge theory and practice at Sydney University. Among the early engineering graduates were J J C Bradfield of Sydney Harbour Bridge fame and J W Roberts who designed the steel bridges for the North Coast Railway and the double-deck bascule bridge over the Clarence River at Grafton.

The next factor was the economic depression that began in 1892 which saw governments seeking cost-effective infrastructure. American steel Pratt trusses were structurally and economically more efficient, much quicker to erect and easier to maintain; no more lattice bridges were built.

The first use of American steel trusses occurred on the Far North Coast where the railway line from Lismore to Murwillumbah was completed in 1894. Also that year, eminent Public Works Department (PWD) bridge engineer Percy Allan designed a modified timber Howe truss road bridge about which the 1894 PWD Annual Report said "In each truss there was a saving of 450 cubic feet of timber and shorter lengths of timber were used giving greater ease in framing together. The cost saving is in the order of 20 per cent. It will now permit the bridging of large rivers which cost had hitherto rendered prohibitory" – music to Treasury ears.

North Coast Railway Bridges

PWD engineers estimated that around 6,000 tonnes of steel would be required for the trusses and plate web girders. The engineer most responsible for their designs was James Waller Roberts. He was born in 1871 at Maryborough, Queensland and became a brilliant student, then went on to graduate in engineering with Honours at Sydney University. He remained with railway engineering to eventually become Principal Designing Engineer of the Way and Works Branch 1920-1932. In 1910 he wrote his definitive paper on railway bridge engineering and introduced the American bridges as follows "The 1889 Hawkesbury River bridge, designed and manufactured in America, was the first use of steel for bridges, from which the American influence was felt. We find departmental designs of the Pratt type trusses using imported steel. In the present designs, the best features of the foregoing examples have been preserved and modifications made to the joints, a return to riveted rather than pinned joints." The use of American bridges had been consolidated.

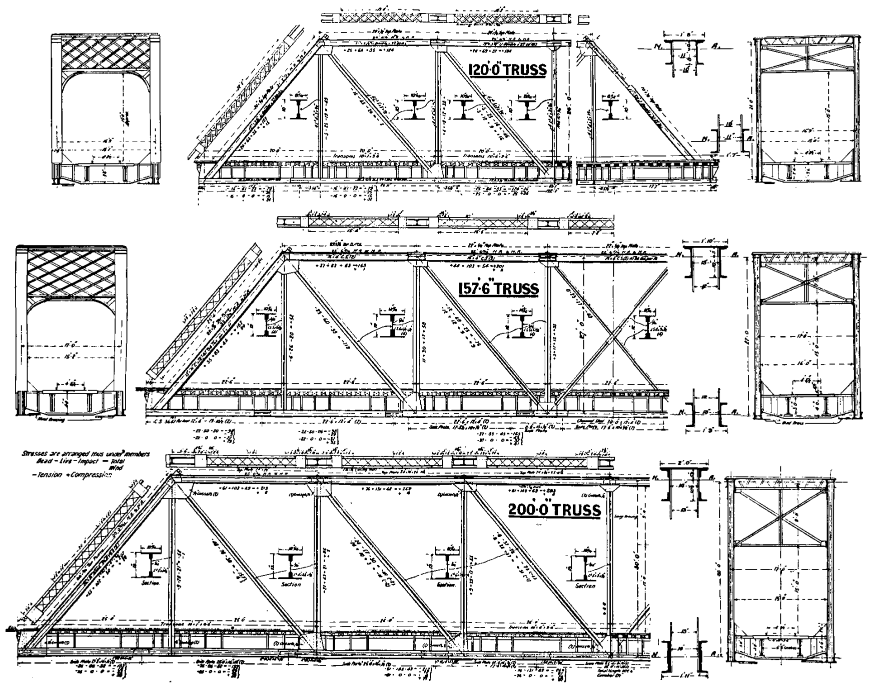


J W Roberts (Family records)

He made a rational decision to use three sizes of steel Pratt trusses, 61 m, 48 m and 36.6 m for the major river crossings, 20 m plate web girders for spans less than 30 m and 8 m timber beam spans for the smallest waterways and approach viaducts.

Initially, the steel bridges were fabricated in Sydney and erected by Sydney-based contractors. Then fabrication took place at the State Dockyard, Walsh Island, Newcastle, and erection was done by PWD day labour.

All steel bridges are still in service but all the timber structures have been replaced by welded galvanised steel girders.



Steel Pratt railway trusses designed by J W Roberts (his 1910 paper)

Henceforth, steel Pratt trusses became the standard long-span railway bridge such that with the early ones in 1894 through to 1925, sixty had been built.

The Clarence River Bridge

In 1922 the Government decided to have a road crossing of the Clarence River as well. The simplest and cheapest solution was to put the road on top of the railway trusses, hence a double-deck bridge. This required a double-deck bascule span and J W Roberts chose the American patented Rall-type. It was officially operational on 8 May 1932.

Conclusion

The North Coast Railway and the Clarence River Bridge have a unique place in Australia's railway and cultural history. The domination of British bridge technology had been abruptly severed in 1894 with the introduction of American bridges. All the original steel bridges continue in service and now constitute an historic set of infrastructure of high heritage significance.

Don Fraser

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